3/11

$N = mg$

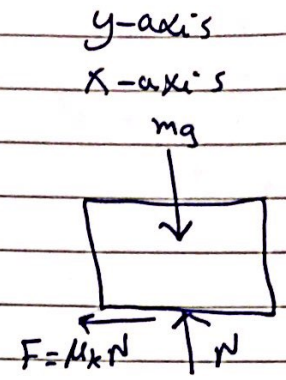
$ma = -\mu_k N$

$ma = -\mu_k mg$

$a = -\mu_k g$

$a = -(0.4)(9.81)$

$= -3.92 \text{ m/s}^2$



from $v^2 - v_0^2 = 2a(x - x_0)$

$0 - 7^2 = 2(-3.92)(x - 0)$

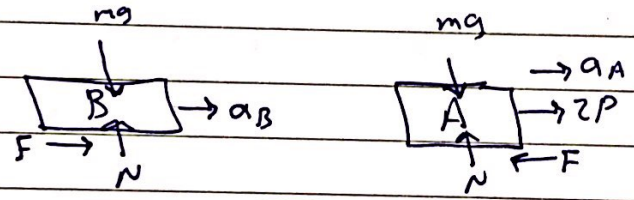
$x = 6.24 \text{ m}$

$v = v_0 + at$

$0 = 7 - 3.92t \Rightarrow t = 1.784 \text{ s}$

(a) FBD

3/24



$F_{max} < F$ occure

$F_{max} > F$ not occure

* $F_{max} = \mu_k N$

$= \mu_k mg$

$= .5 \times 20 \times 9.81 = 98.1 \text{ N} < 2 \times 60 = 120 = P$

Block A

$\Sigma F = ma \rightarrow (A)$

$2P - F = m_A a_A$

$2 \times 60 - 98.1 = 20a \Rightarrow a_A = 1.095 \text{ m/s}^2$

$\Sigma F = ma \rightarrow (B)$

~~$2P$~~ $F = m_B a_B$

~~2×60~~ $98.1 = 100 a_B \Rightarrow a_B = 0.981 \text{ m/s}^2$

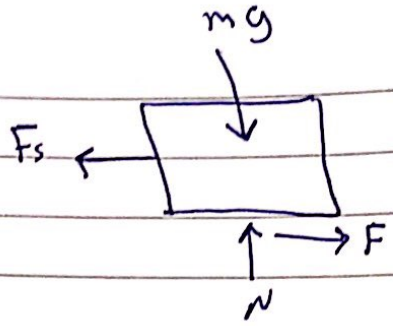
(b) $F = 2P$

$F = 2 \times 40 = 80 < F_{max}$

$\Sigma F = ma$

$80 = 120a \Rightarrow a = 0.667 \text{ m/s}^2$

3/35



(a) $X = 50\,mm = 0.05\,m$

$F_s = (150 \times 0.05) + (400 \times 0.05^2)$

$= \underline{8.5\,N}$

$F = F_s$

$F = \underline{8.5\,N}$

$F_{max} = \mu_s \times N$

$= 0.3 \times 6 \times 9.81 = \underline{17.658\,N}$

So, $F < F_{max}$ no motion

$\boxed{a = 0}$

(b) $X = 100\,mm = 0.1\,m$

$F_s = (150 \times 0.1) + (400 \times 0.1^2)$

$F_s = F = 19\,N$

So, $F > F_{max}$ there is motion

Actual $F = \mu_k N$

$= 0.25 \times 6 \times 9.81$

$= \underline{14.715\,N}$

from $\Sigma F_x = ma_x$

$F - F_s = -6a$

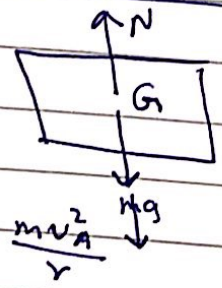
$14.715 - 19 = -6a \Rightarrow \underline{a = 0.714\,m/s^2} \leftarrow$

3/47

(a) $N_A = mg + \frac{mV_A^2}{r}$

$= 0.6 \times 9.81 + \frac{0.6 \times 5^2}{3}$

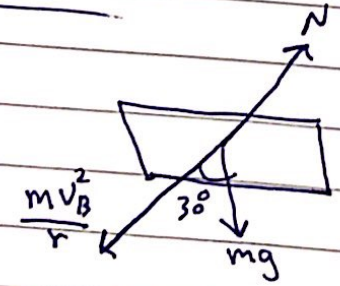
$= \underline{10.89\,N}$



(b) $N_B = mg\cos\theta + \frac{mV_B^2}{r}$

$= 0.6\cos 30 + \frac{0.6 \times 4^2}{3}$

$= \underline{8.30\,N}$



∴ 3151

$\sum F_y = 0$

$N\cos\theta = mg$

$N = \frac{mg}{\cos\theta}$ by dynamics

$\sum F_x = a_x$

$N\sin\theta = \frac{mv^2}{\rho} \Rightarrow 32.2\tan\theta = \frac{v^2}{\rho}$

$32.2\tan\theta = \frac{\left(\frac{400 \times 5280}{3600}\right)^2}{(2 \times 5280)}$

$\tan\theta = 1.01219$; $\boxed{\theta = 45.35^\circ}$

3/111 $P = \frac{\text{change in Energy}}{\text{time}} = \frac{mg(h_2 - h_1)}{t}$

$= \frac{120(9-0)}{5} = 216$ lb-ft/s

$= 0.393$ hp

3/113 $P_{req} = n \times wh$

$= \frac{30}{60} \times 140 \times 24 = 1680$ lb-ft/s

$= \frac{1680}{550} = 3.054$ hp

$e = \frac{P_{req}}{P_{motor}} = \frac{3.054}{4} = 0.7635$

3/114

$\tan\theta = \frac{8}{100} \Rightarrow \theta = 4.57^\circ$

$Q = mgh + \frac{1}{2}m(V_1^2 - V_2^2)$

$= [1200 \times 9.81 \times (500 \sin 4.57)] + \left[\frac{1}{2} \times 1200 \times \left(\left(\frac{100}{3.6}\right)^2 - \left(\frac{25}{3.6}\right)^2\right)\right]$

$= 903$ kJ

3/118 $L = 2L_1 + L_2$

$0 = 2V_1 + V_2$

$0 = (2 \times 2) + V_2 \Rightarrow V_2 = -4$ m/s

$P = FV_2 \Rightarrow P = m_2 g V_2 = 100 \times 9.81 \times 4$

$= 3924$ W

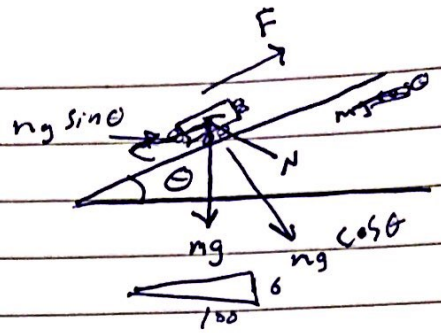
output

$P_o = m_1 g V_1 - m_2 g V_2$

$= (300 \times 9.81 \times 2) - (100 \times 9.81 \times 4) = 1962$ W

$e = \frac{P_o}{P_i} = \frac{1962}{2200} = 0.892$

3|119



$\tan\theta = \frac{6}{100}$

$= \tan^{-1}\left(\frac{6}{100}\right) \Rightarrow \theta = 3.43^\circ$

$v = \frac{100}{3.6} = 27.77 \text{ m/s}$

$v^2 = 2as$

$(27.77)^2 = 2 \times a \times 110$

$a = 3.51 \text{ m/s}^2$

to Balance $F - mg\sin\theta = ma$

$F - 1700 \times 9.81 \times \sin(3.43) = 1700 \times 3.51$

$F = 6965 \text{ N}$

$P = Fv$

$= 6965 \times 27.77 = 193.4 \text{ kW}$

* to halfway

$P = F \times v_{\frac{1}{2}} \Rightarrow F \times \sqrt{2 \times a \times s_{\frac{1}{2}}}$

$= 6965 \times \sqrt{2 \times 3.51 \times \frac{110}{2}}$

$= 136.7 \text{ kW}$

3|176 Law of conservation of Linear momentum

$m_i v_i = m_f v_f$

$0.075(600) = (50)(v_f)$

$v_f = 0.899 \text{ m/s}$

initial $T_1 = \frac{1}{2} m_i v_i^2 \Rightarrow \frac{1}{2} \times 0.075 \times (600)^2 = 13500 \text{ J}$

final $T_2 = \frac{1}{2} m_f v_f^2 \Rightarrow \frac{1}{2} \times (0.075 + 50) \times (0.899)^2 = 20.23 \text{ J}$

$|\Delta E| = |T_1 - T_2| = 13479.77 \text{ J}$

3/177 $F = m\frac{dv}{dt}$

$2T_0 - \Delta R = m\frac{(v_2 - v_1)}{dt}$

$m = 10\,mg \longrightarrow 10^4\,kg$

$T_0 = 8\,kN$

$2 \times 8000 - \Delta R = 10^4 \times \frac{\left(\frac{1050}{3.6} - \frac{1000}{3.6}\right)}{9}$

$16000 - \Delta R = 15432.098 \Rightarrow \underline{\Delta R = 567.9\,N}$

3/178 $U = \Delta T$

$Fd = \frac{1}{2} m_b (v_f - v_i)^2$

$U_k \times m_b \times g \times d = \frac{1}{2} m_b (v_f - v_i)^2$

$m_1 v_1 = m_2 v_2 + m_b v_i$

$(0.06)(600) = (0.06)(400) + 3(v_i)$

$3v_i = 12 \Rightarrow \underline{v_i = 4\,m/s}$

$U_k \times 3 \times 9.81 \times 2.7 = \frac{1}{2} \times 3 \times (0 - 4)^2$

$\underline{U_k = .302}$

3/184 $T \times t = \frac{1}{2} \times 2(800) + 2(800)$

$t \times T = 2400\,N\text{-}s$

$\int F_y\,dt = m(v_2 - v_1)$ Impulse-momentum Eq.

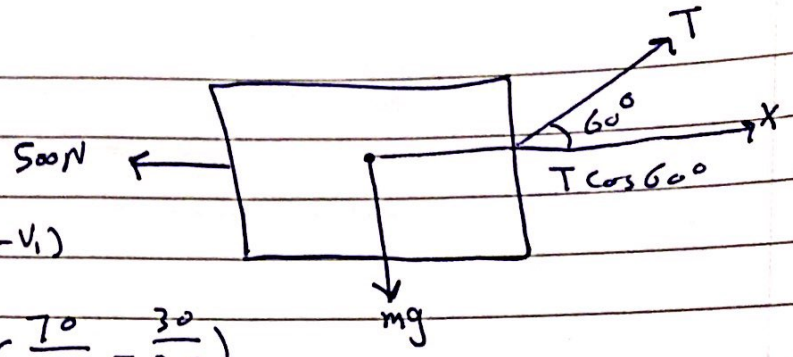
$t(mg - T) = m(v_2 - v_1)$

$200(1.62)(5) - 2400 = 200(v_2 - 6)$

$\underline{v_2 = 2.10\,m/s \rightarrow 5_s}$

3/189

$F = m\frac{dv}{dt}$

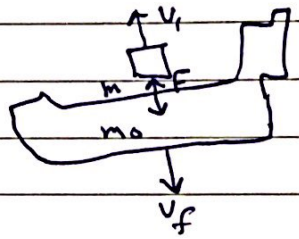


$(T\cos 60^\circ - 500N) \times dt = m(V_2 - V_1)$

$(T\cos 60^\circ - 500N) \times 15 = 1200\left(\frac{70}{3.6} - \frac{30}{3.6}\right)$

$T = 2777.77\ N$

3/193 $mV_1 = m_0 V_f$



$800 V_1 = 90000\ V_f$

$800(0.3 - V_f) = 90000\ V_f$

$V_f = \frac{800 \times 0.3}{800 + 90000}$ $\quad V_f = 0.00264$ m/s

$\Sigma F dt = m_0 V_f$

$F_{av} t = m_0 V_f$

$F_{av}(4) = 90000(0.00264)$

$F_{av} = \frac{237.6}{4} = 59.4\ N$

3/200 (a) $G_1 = G_2$

$m_A V_1 + m_B (V_1)_B = (m_A + m_B) V'$

$\frac{4000}{32.2}(20) + 0 = \left(\frac{4000 + 2000}{32.2}\right) V' \quad \left(\frac{4000}{32.2} + \frac{2000}{32.2}\right) V'$

$V' = 13.33$ mi/hr

(b) Acceleration A

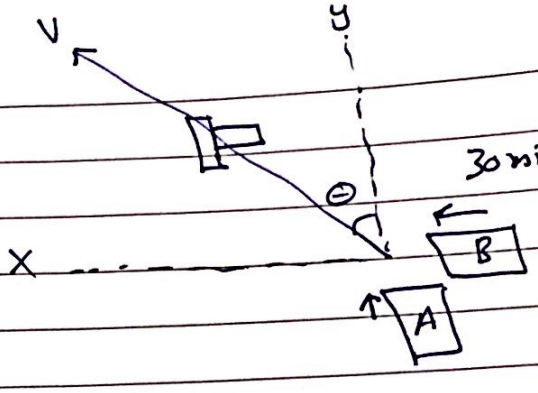
$a_A = \frac{dv}{dt} = \frac{v' - v}{\Delta t} = \frac{13.33 - 20}{0.1} \times \frac{5280}{3600} = -97.83\ ft/s^2$

$a_B = \frac{dv}{dt} = \frac{v' - 0}{\Delta t} = \frac{13.33}{0.1} \times \frac{5280}{3600} = 195.51\ ft/s^2$

(c) Using impulse-momentum Eq. $m(V_A)_1 - R \times \Delta t = m(V_A)_2$

$R = \frac{m(V_A)_1 - m(V_A)_2}{\Delta t} = \frac{\frac{4000}{32.2}[20 - 13.33] \times \frac{5280}{3600}}{0.1} = 12152.38\ lb$

3/203



$\Delta G_x = 0$

$m_b v_{b_1} = (m_b + m_a) v_x$

$3200(30) = (3200+3400) v \sin\theta$

$96000 = 6600 (v \sin\theta)$

$v \sin\theta = 14.545$ mi/hr —①

$\Delta G_y = 0$

$m_a v_{a_1} = (m_b + m_a) v_y$

$3400(20) = 3200+3400\ v\cos\theta$

$68000 = 6600 (v\cos\theta)$

$v\cos\theta = 10.303$ mi/hr

$v = \sqrt{(v\sin\theta)^2 + (v\cos\theta)^2}$

$= \sqrt{14.545^2 + 10.303^2} = 17.824$ mi/hr

$\frac{v\sin\theta}{v\cos\theta} = \frac{14.545}{10.303}$

$\tan\theta = 1.4117$

$\theta = 54.69^\circ$

$$\vec{V} = \vec{w} \times \vec{r}$$

5/4 $a = \frac{w_2 - w_1}{t}$

$a = \frac{800 - 200}{4/60} = 9000$ $\quad \alpha = \frac{w_2 - w_1}{t}$

$N = 200 \times \frac{4}{60} + \frac{1}{2} \times 9000 \times (\frac{4}{60})^2$ $\quad$ from $\Delta\theta = w_0 t + \frac{1}{2}\alpha t^2$

$= 33.33$ rev.

5/6 * Velocity at A, $V_A = 40$ mi/hr

$= 40 \times \frac{5280}{3600} = 58.667$ ft/s

* Velocity at B, $V_B = 50$ mi/hr

$= 50 \times \frac{5280}{3600} = 73.33$ ft/s

$\rho = 180$ ft

$\theta = 30°$

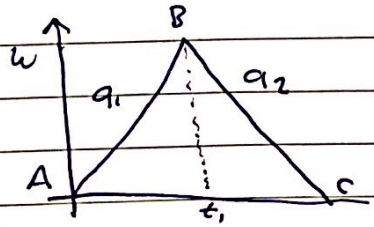
* At B; $r = 180 - \frac{18}{12} = 178.5$ ft

$w = \frac{v}{r} = \frac{73.3}{178.5} = 0.411$ rad/s

* Between A and B; $w_{av} = \frac{\Delta\theta}{\Delta t} = \frac{30 \times \frac{\pi}{180}}{1.52} = 0.344$ rad/s

5/a $a_1 = a_2$

So $t_1 = \frac{10}{2} = 5$ s



from $w = w_0 + at$

$3600 = 0 + a \times \frac{5}{60}$

$a = 43200$ rev/min^2

total rev. for ABC

$N = (w_0 t + \frac{1}{2} a t^2) \times 2$

$= [0 + \frac{1}{2}(43200)(\frac{5}{60})^2] \times 2$

$\theta = 300$ rev

$V_C = \omega r$

$\omega = \frac{1.5}{0.075} = 20 \text{ rad/s}$

$V_A = \omega \times R = 20 \times 0.15 = \underline{3 \text{ m/s}}$

(a)

$a_A^2 = (a_A)_t^2 + (a_A)_n^2$

$(a_A)_t = \alpha \cdot R$

$(a_A)_n = \frac{V_A^2}{R}$

$(75)^2 = (\alpha \times 0.15)^2 + \left(\frac{3^2}{0.15}\right)^2$

$(75)^2 - \left(\frac{3^2}{0.15}\right)^2 = (\alpha \times 0.15)^2$

$\alpha \times 0.15 = \sqrt{75^2 - \left(\frac{3^2}{0.15}\right)^2} = 45$

$\alpha = \frac{45}{0.15} = 300 \text{ rad/s}^2$

(b) total acceleration Point B

$a_B^2 = (a_B)_t^2 + (a_B)_n^2$

$(a_B) = \sqrt{(300 \times 0.075)^2 + \left(\frac{1.5^2}{0.075}\right)^2} = 37.5 \text{ rad/s}^2$

(c) total acceleration Point C

$a_C = \alpha \cdot r$

$= 300 \times 0.075 = \underline{22.5 \text{ rad/s}^2}$

5/160

$\vec{V}_A = \vec{V}_O + \vec{V}_{A/O}$

$V_{A/O} = \frac{10}{12} w \ \frac{ft}{sec}$

from $V_{A/O} = r \times w$

$V_A = 4$ ← • → $V_O = 4$

(a) $V_{A/O} = \vec{V}_A - \vec{V}_O$

$\frac{10}{12} w = -4 - 4 \Rightarrow V_{A/O} = 8 \ ft/sec$

$w = \frac{8}{10/12} = 9.6 \ rad/sec$

$N = 9.6 \times \frac{60}{2\pi} = 91.7 \ rev/min \quad CCW$

(b) $V_{A/O} = \vec{V}_A - \vec{V}_O$

$\frac{10}{12} w = 0 - 4 = 4 \ ft/sec$

$w = \frac{4}{10/12} = 4.8 \ rad/sec$

$N = 4.8 \times \frac{60}{2\pi} = 45.8 \ rev/min \quad CCW$

(c) $V_{A/O} = \vec{V}_A - \vec{V}_O$

$\frac{10}{12} w = 8 - 4 = 4 \ ft/sec$

$w = \frac{4}{10/12} = 4.8 \ rad/sec$

$N = 4.8 \times \frac{60}{2\pi} = 45.8 \ rev/min \quad CW$

5/161

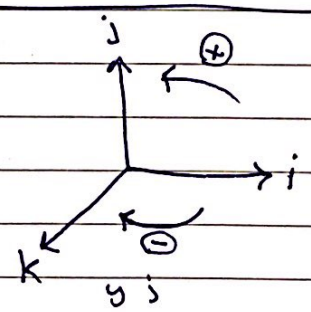
$v = v_O$

$v_O = 107257 j \ km/h$

$R\omega = 6371(10^3)[7.292 \times 10^{-5}]$

$= 465 \ m/s \times 3.6$

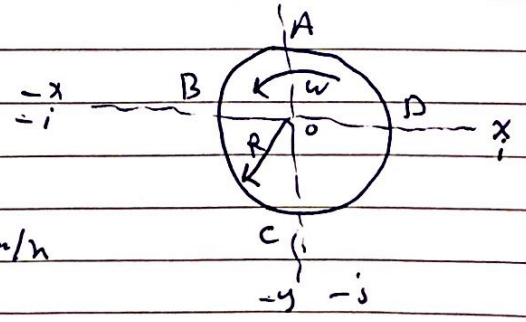
$= 1672 \ km/h$



$v_A = v_O + v_{A/O} = -1672 i + 107257 j \ km/h$

$v_B = v_O + v_{B/O} = 107257 j - 1672 j$

$= 105585 j \ km/h$



$v_C = v_O + v_{C/O} = 1672 i + 107257 j \ km/h$

$v_D = v_O + v_{D/O} = (107257 + 1672) j$

$= 108929 j \ km/h$

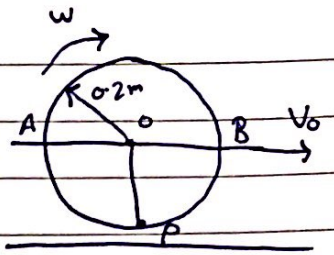
5/64

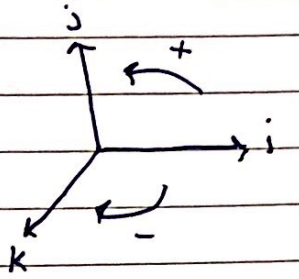
$\vec{V}_P = \vec{V}_O + \vec{V}_{PO}$

$\vec{V}_O = 0.7i$ m/s

$\vec{\omega} = -2k$ rad/s → clockwise

$\vec{r}_{PO} = -0.2j$





$\vec{V}_P = \vec{V}_O + \vec{V}_{PO} \Rightarrow \vec{V}_O + \vec{\omega} \times \vec{r}_{PO}$

$= 0.7i + [-2\vec{k} \times (-0.2j)]$

$= 0.7i + 0.4i = 0.3i$ m/s

$\vec{V}_A = \vec{V}_O + \vec{V}_{AO} \Rightarrow \vec{V}_O + \vec{\omega} \times \vec{r}_{OA}$

$= 0.7i + [-2\vec{k} \times (-0.2i)]$

$= 0.7i + 0.4j$ m/s

5/72

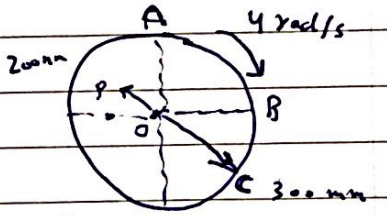
$V_{A/B} = \vec{\omega} \times \vec{r}_{A/B}$

$\omega = -4k$ rad/s

$\vec{r}_{A/B} = 0.3j - 0.3i$ m

$\vec{V}_{A/B} = -4k \times 0.3(-i+j)$

$= 1.2(i+j)$ m/s $= 1.2j + 1.2i$ m/s



$\vec{V}_P = \vec{V}_O + \vec{V}_{P/O} = r\omega i + P/O\ \omega j$

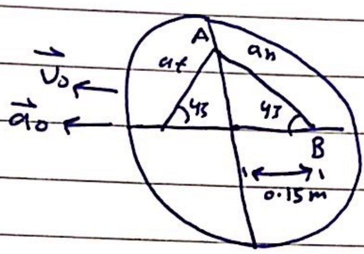
$= 4(0.3i + 0.2j)$ m/s

$\vec{V}_P = 1.2i + 0.8j$ m/s

5/125 إياها
اثبات مهم ابو محمد

5/126

$$r_{AB} = \sqrt{(0.150)^2 + (0.150)^2}$$



$$= 0.150\sqrt{2} \ \text{m}$$

$$a_n = r_{AB}\, w^2$$

$$w^2 = \frac{a_n}{r_{AB}} = \frac{2.7 \cos 45}{0.150\sqrt{2}} = 9 \Rightarrow \underline{w = 3 \text{ rad/s}}$$

$$a_t = r_{AB}\, \alpha$$

$$\alpha = \frac{a_t}{r_{AB}} = \frac{2.7 \cos 45}{0.150\sqrt{2}} = \underline{9 \text{ rad/s}^2}$$

$$* \ \vec{V_o} = -r w i$$

$$= -(0.2)(3)i = \underline{-0.6i \ \text{m/s}}$$

$$* \ \vec{a_o} = -r \alpha i$$

$$= -(0.2)(9)i = \underline{-1.8i \ \text{m/s}^2}$$

5/128

$$a_o = \frac{G m_s}{r^2} = \frac{G m_e k}{r^2}$$ ← ثوابت يعطيك إياهم

$$= \frac{6.673 \times 10^{-11} \times 5.976 \times 10^{24} \times 333000}{(149.6 \times 10^9)^2}$$

$$a_o = 0.059935 \ \text{m}^2/\text{s} \leftarrow$$

$$= -0.059935 \ \text{m}^2/\text{s}$$

acceleration $\Rightarrow a_{B/o} = R w^2$

$$= 6371 \times 10^3 \times (7.292 \times 10^{-5})$$

$$= 0.0338 \ \text{m}^2/\text{s}^2$$

acceleration Point B

$$a_B = a_o + a_{B/o} = -0.005933i + 0.03388i$$

$$= \underline{0.02794i \ \text{m}^2/\text{s}^2}$$

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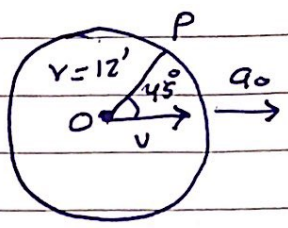
5/130

$$a_p = a_o + (a_{p/o})_n + (a_{p/o})_t$$



$$(a_{p/o})_n = r\omega^2 = r\left(\frac{v}{r}\right)^2 = \frac{v^2}{r}$$

$$(a_{p/o})_t = r\alpha = r\left(\frac{a_o}{r}\right) = a_o$$

For $(a_p)_{horiz} = 0$, $v^2 \cos 45 = 12 + 12\cos 45^\circ \Rightarrow$ $\cos 45$ نقسم على

$$v^2 = 29 \text{ ft}^2/\text{sec}^2$$

$$= \underline{5.38 \text{ ft/sec}}$$

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